



Exploration Systems Mission Directorate Overview

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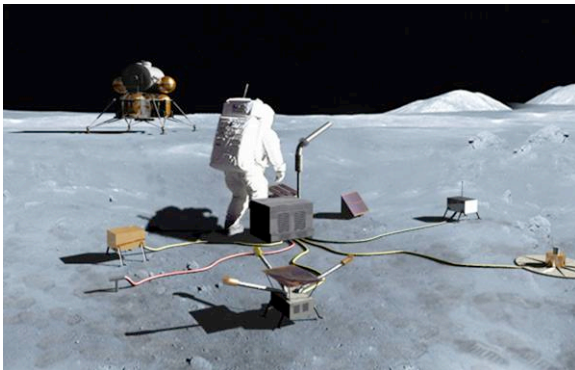
NASA Exploration Systems Mission Directorate

June 1, 2006

A Bold Vision for Space Exploration, Authorized by Congress



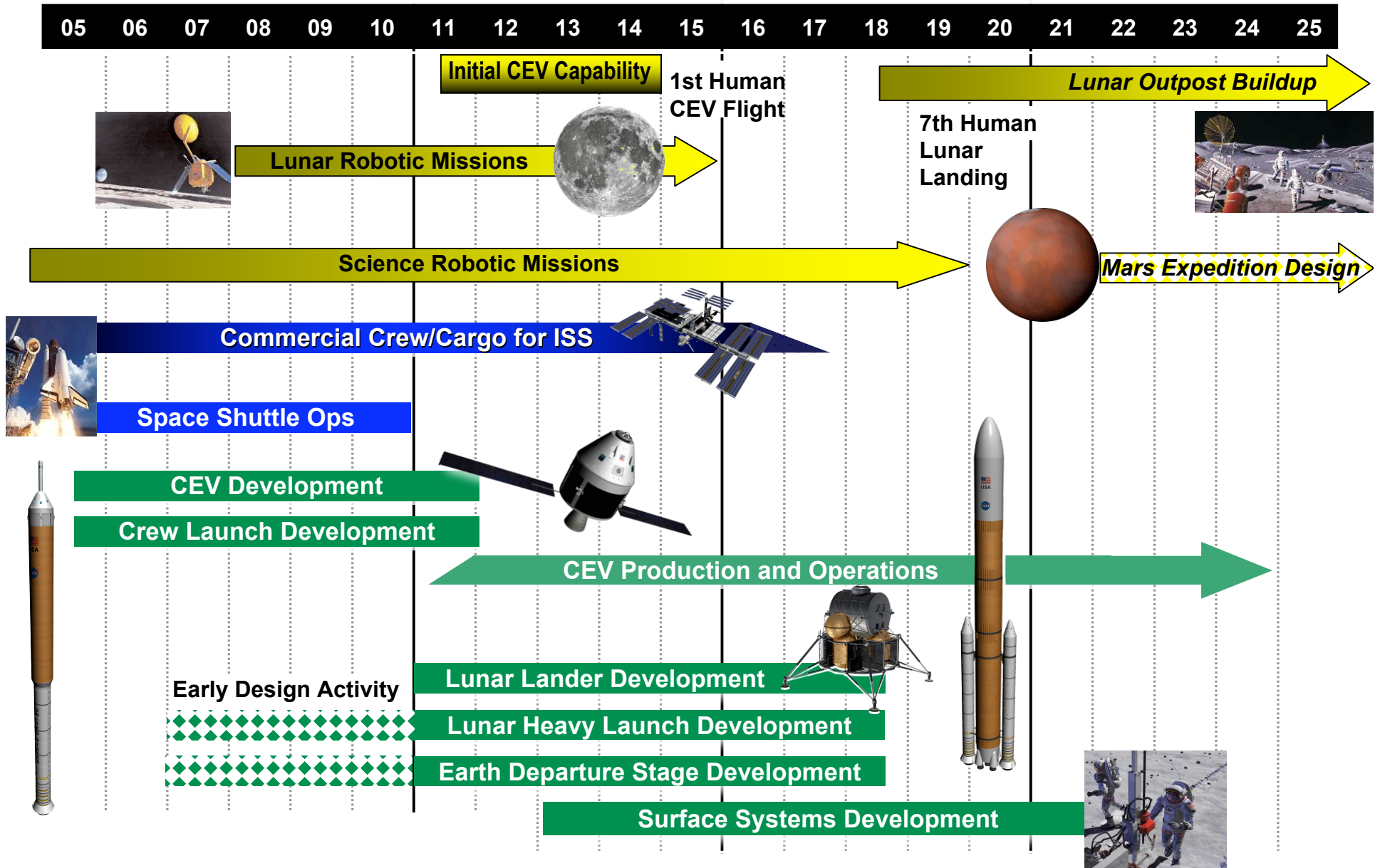
- Complete the International Space Station
- Safely fly the Space Shuttle until 2010
- Develop and fly the Crew Exploration Vehicle no later than 2014 (goal of 2012)
- Return to the Moon no later than 2020
- Extend human presence across the solar system and beyond
- Implement a sustained and affordable human and robotic program
- Develop supporting innovative technologies, knowledge, and infrastructures
- Promote international and commercial participation in exploration



NASA Authorization Act of 2005

The Administrator shall establish a program to develop a sustained human presence on the Moon, including a robust precursor program to promote exploration, science, commerce and U.S. preeminence in space, and as a stepping stone to future exploration of Mars and other destinations.

NASA's Exploration Roadmap



Crew Exploration Vehicle (CEV)

- **Command Module**

- Mold Line: Apollo-Derived Capsule
- Crew: 6 for ISS & Mars, 4 for Moon
- Size: 16.4 ft (5 Meter) Diameter
- Docking Mechanism: APAS or LIDS

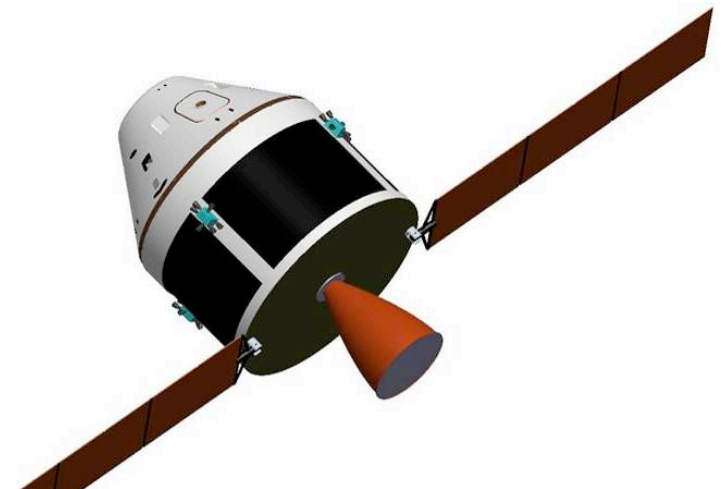


- **Service Module**

- Propulsion: Industry Propose Best Solution
- Some Capability for Delivering Unpressurized Cargo

- **Ongoing Analysis**

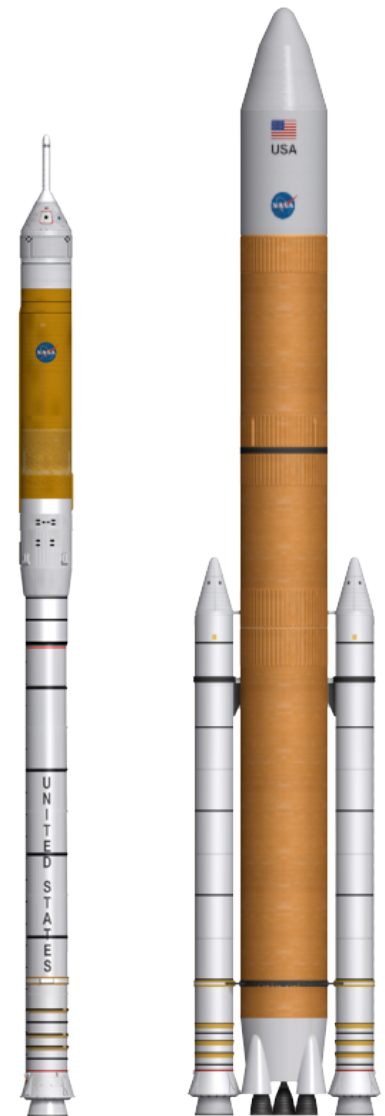
- Impact of Reducing Volume
- Trading Functionality between Command and Service Module
- Eventual Migration to Non-Toxic Propellants



Crew Launch Vehicle (CLV) Heavy Launch Vehicle (HLLV)



- **Crew Launch Vehicle**
 - Single 5 segment RSRB/M 1st stage
 - Upper stage powered by a single engine derived from the Saturn J-2
- **Cargo Launch Vehicle**
 - Twin 5 segment RSRB/M 1st stage (from CLV)
 - Core stage derived from the External Tank
 - Powered by 5 RS-68s
 - CLV-derived avionics
- **Earth Departure Stage**
 - Upper stage derived from the External Tank
 - Powered by a single J-2 derived engine - 2 burn capability
 - CLV-derived main propulsion systems and avionics



The Moon - the 1st Step to Mars and Beyond....



- Regaining and extending operational experience in a hostile planetary environment
- Developing capabilities needed for opening the space frontier
- Preparing for human exploration of Mars
- Science operations and discovery
- Enabling national, commercial and scientific goals for the development and use of the Moon

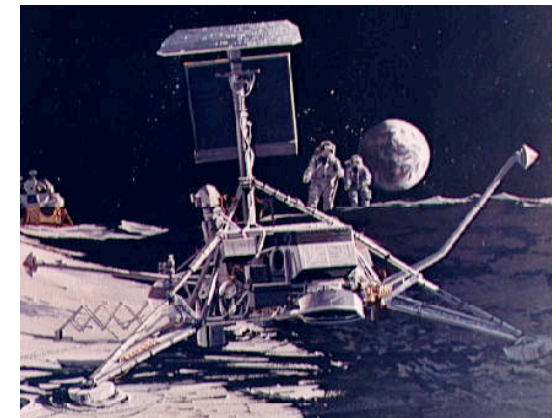
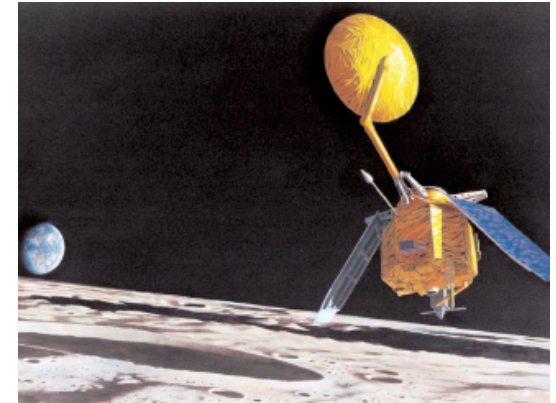


Next Step in Fulfilling Our Destiny As Explorers

Robotic Lunar Exploration Program (RLEP)



- Provide early information for human missions to the Moon
- Evolvable to later human systems
- Most unknowns are associated with the North and South Poles – a likely destination for a lunar outpost
- Make exploration more capable and sustainable
- Key requirements involve establishment of
 - Terrain and surface properties
 - Knowledge of polar regions
 - Support infrastructure
- Lunar Reconnaissance Orbiter (LRO)
- Provides major scientific and exploration benefit by 2009
- Selected instruments complement other foreign efforts
- LRO launch planned for October 2008; one-year mission
- RLEP 2

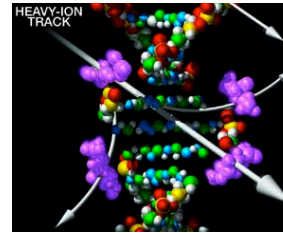


Human Research & Technology Development



Human Research Major Areas of Investment:

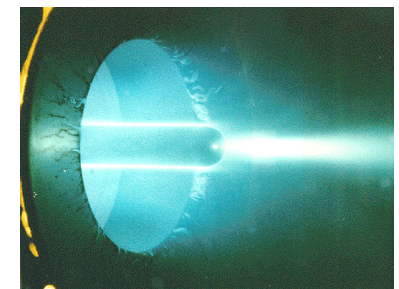
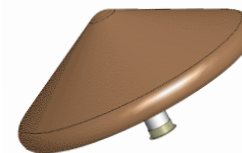
- Space Radiation Research
- Exploration Medical Capability
- ISS Research Capability
- Physiological Countermeasures
- Behavioral Health
- Human Factors and Environmental Standards



Technology Development:

Mature key technologies to support CEV, CLV, RLEP, and lunar sortie missions

- | | |
|-----------------------|--|
| • Structures | • Environmental Control & Life Support |
| • Protection | • Crew Support & Accommodations |
| • Propulsion | • Mechanisms |
| • Power | • In-Situ Resource Utilization |
| • Thermal Control | • Analysis & Integration |
| • Avionics & Software | • Operations |





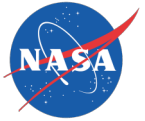
Commercial

Centennial Challenges

- Program of contests with cash purses to stimulate innovation and competition in technical areas of interest to space exploration and ongoing NASA priorities
- Four Categories of Challenges / Purses
 - Flagship / Tens of Millions
 - Keystone / \$.5 - 1 Million
 - Alliance / up to \$250,000
 - Quest / Promote science, technology, engineering, and math (all ages)

Commercial Crew/Cargo Project

- Challenge to U.S. industry to establish capabilities and services to open new space markets
- May eventually support the transportation needs of the ISS
- Phase 1 draft announcement released December 5, 2005
- Proposals due March 3, 2006
- Agreements expected to be awarded this summer



ESMD Areas of Emphasis

Spacecraft

- Guidance
- Navigation and control
- Thermal
- Electrical
- Structures
- Software
- Avionics
- Modeling
- Power systems
- Interoperability/ commonality
- Advanced spacecraft materials
- Crew/vehicle health monitoring
- Life support
- High speed re-entry

Propulsion

- Propulsion methods that will utilize materials found on the moon or Mars
- “Green” propellants
- On-orbit propellant storage
- Motors
- Fuels
- Manufacturing
- Soft landing
- Throttleable propellants
- High performance
- Descent

Ground Operations

- Pre-launch
- Launch, mission operations
- Command and control software systems
- Communications
- Re-entry
- Landing
- Recovery

Lunar and Planetary Surface Systems

- Precision landing hardware, software, and navigation systems,
- Extended surface operations
- Environmental analysis
- Robotics
- Radiation protection
- Spacesuits
- Life support
- Environmental shielding
- Power systems

System Engineering